1-dB Chebyshev Filter/Amplifier

003

Butterworth filters, and to a lesser degree Bessel filters, are probably the most commonly used types of analogue filters. However, in circuits where steep skirts are required it is necessary to us higher-order versions of these filters, which means more components and higher costs. In such cases, a possible alternative is to use a different type of filter, and in particular a Chebyshev filter, since it has considerably steeper skirts for the same order. The only disadvantage of this type of filter is the ripple in the passband and the associated overshoots in the square-wave response (much worse than with Butterworth filters), but it is possible to select component values to control the amount of ripple.

Here is an example of a third-order Chebyshev filter with a ripple of 1 dB. Although active filters are almost always combined with unity-gain buffers, this is by no means mandatory. Most filters can be readily combined with a voltage amplifier. Since this renders a supplementary amplification stage unnecessary, we have gratefully taken advantage of this possibility in the design presented here.

The illustrated low-pass filter thus has a ripple of 1 dB, with the rated frequency passing through the –1-dB point. The 'true' corner frequency (–3 dB) is only 9.4% higher. We have printed two tables. **Table 1** lists the theoretical capacitor values, for a circuit having three equal resistor values, for six dif-

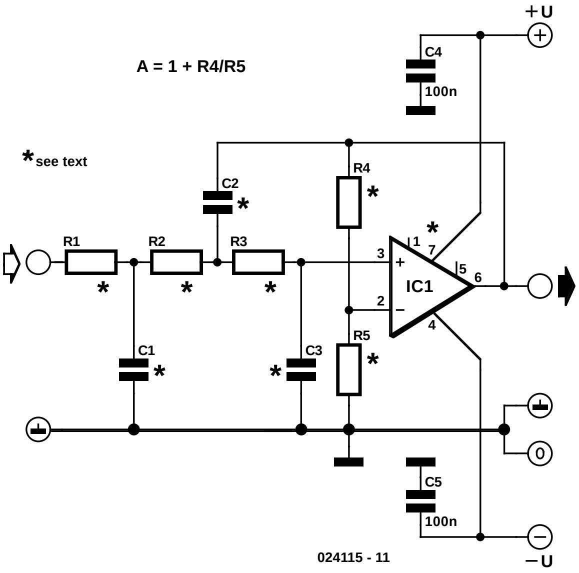

Table 1: 3 x 10 kΩ, 1 kHz (f_c = –1 dB!)

A[dB]	C1	C2	C3
0	37.314 n	235.31 n	934.56 p
5	43.422 n	20.175 n	9.3665 n
6	44.283 n	17.746 n	10.442 n
10	47.708 n	11.836 n	14.532 n
14	51.504 n	8.4738 n	18.801 n
20	58.426 n	5.3733 n	26.137 n

Table 2: 1 kHz (f_c = –1 dB!), caps : E-12

A[dB]	C1	R1	C2	R2	C3	R3
0	39 n	9.5283 k	220 n	9.8193 k	1 n	10.222 k
5	47 n	9.3191 k	22 n	9.0553 k	10 n	9.4040 k
6	47 n	9.4716 k	18 n	9.5007 k	10 n	10.778 k
10	47 n	10.182 k	12 n	9.9738 k	15 n	9.5505 k
14	47 n	11.391 k	8.2 n	10.136 k	18 n	10.244 k
20	56 n	11.229 k	5.6 n	9.2570 k	27 n	9.3231 k

ferent gain levels, namely 0 dB (1 ×), 5 dB (1.778 ×), 6 dB (2 ×), 10 dB (3.162 ×), 14 dB (5 ×) and 20 dB (10 ×). The first table is also necessary if you want to convert the filter from low-pass to high-pass.

Table 2 shows more practical component values for the same gains. Exact E12 values have been used for the capacitors, and we have calculated the theoretical values of the resistors for you so they can be implemented very accurately by connecting two E96 values in parallel.

At the higher gain levels, and particularly at high frequencies, a very fast type of opamp must be used to avoid having it affect the signal transfer. In order to keep deviations (in frequency and amplitude) as small as possible, the use of 1% components is highly recommended (especially at higher gains).

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